

## Update on Vitreo Retinal Surgery.

**Lingam Gopal**

*Director, Research, Vision Research Foundation & Consultant, Vitreoretinal services,  
Neurophthalmology, Sankara Nethralaya, Chennai-600 006, India*

**Abstract:** Vitreo retinal surgery has seen a sea of change since its introduction by Robert Machemer. The indications for vitrectomy have expanded dramatically and hitherto inoperable conditions have become amenable to surgical treatment. The advent of 23 and 25 gauge vitrectomy is an important milestone. In addition to improvisation in the design of intraocular instruments, we have seen over a period of time additions to the armamentarium of the vitreo retinal surgeon, in the form of various dyes to enable better visualization and a more complete removal of vitreous and membranes. The future may see increased usage of enzyme assisted vitrectomy. Improvements in the design of the retinal prosthesis could see its increased acceptance and possibly a more wide spread usage.

### INTRODUCTION

The introduction of pars plana surgery by Dr Robert Machemer<sup>1</sup> was an important milestone in the surgical management of vitreo retinal diseases. A lot of modifications have since taken place in the instrumentation. With increasing expertise, more and more diseases have become amenable to surgical management. This article gives a bird's eye view of the recent developments in this field.

### INSTRUMENTATION

While the initial instruments were 16 gauge and combined all the functions of infusion, suction, cutter and even illumination (VISC, Vitreophage, Rotoextractor), they were quickly replaced by the 20 gauge instruments with split functions (Connor O' Malley's Ocutome). A 3 port vitrectomy has become the standard of care with a sewed on infusion cannula, usually placed infero-temporally, while the upper two sclerotomies are used for the active instruments. Except for the intra ocular magnet and foreign body forceps (usually 19 or 18 gauge), all instruments were of the 20 gauge size. Innovations include the reduction in size of the instruments, newer design of instruments, changing illumination techniques and changing visualization techniques.

**Vitreous cutter:** 23 and 25 gauge instruments<sup>2</sup> are increasingly being used for simple and sometimes even complicated surgeries. Suture less vitrectomy is made possible with the reduction of the size of the instruments, along with the two step entry methods that have been adopted. Most of the intra ocular instruments have been made available in the smaller gauge so that enlargement of the sclerotomy is rarely required. Even injection and extraction of viscous fluid (silicone oil) is possible. The instruments however tend to bend easily (despite recent innovations in the hardness of the metal used for the instruments) and hence complicated diabetic vitrectomies, surgery for severe PVR, and intra ocular foreign body etc still require a 20 gauge surgery.

**High speed cutters:** The present generation cutters have cut rates up to 5000 times per minute. The foot switch can be programmed to control the suction and cut rate simultaneously for various steps of the surgery (3D control). The opening in the probe is also placed closer to the tip enabling close shaving of the vitreous from the retinal surface. The duty cycle is also adjusted so that despite high cut rates, the port remains open for long enough time to enable adequate suction to take place<sup>3</sup>.

**Newer design of instruments:** A variety of forceps and spatulas are available for various steps of the surgery. Internal limiting membrane peeling is made simple with the availability of fine forceps that can hold this extremely thin membrane.

### ILLUMINATION

Xenon light source has given brilliant illumination compared to the halogen light source. The torpedo light pipe can be fixed separately through a small 25 gauge opening providing chandelier type illumination so that true bimanual surgery is possible.

**Visualization:** Wide angle viewing systems (BIOM, EIBOS etc) have become the norm. The new microscopes have foot switch control for the focusing of the BIOM and the image inverter automatically comes into place when the lens is brought in to position.

Control of the intra ocular pressure during surgery is possible more precisely in some of the recent designs, using a system where air is pumped into the infusion bottle and drives the fluid at a fixed pressure. Sensors can detect excessive leak from sclerotomies and compensate for the same by increasing the infusion rate.

A plethora of forceps, scissors and spatulas are available for various purposes. Procedures like internal limiting membrane removal are made relatively easy by these precision made forceps.

The endoscope is another innovation, although of limited use and can be a value addition to the armamentarium of the vitreo-retinal surgeon<sup>4</sup>. It is of special use in cases with temporary corneal opacification and associated posterior segment problem needing surgery as in traumatized eyes. Use of endoscope eliminates the need for combining the posterior segment surgery with corneal grafting. Endoscopes can also be potentially useful in retinal reattachment surgery in eyes with permanent keratoprosthesis.

### INTERNAL TAMPONADING AGENTS

Norton<sup>5</sup> introduced use of expansile gases such as sulphur hexafluoride and perfluoro propane while Cibis introduced silicone oil<sup>6</sup>. Silicone oil was initially used without vitrectomy more as an instrument rather than tamponading agent. It was Zjovonovic<sup>7</sup> who popularized the use of silicone oil as a tamponading agent after a thorough vitrectomy and mobilization of the retina. In addition to the availability of different viscosities of silicone oil (1000 and 5000 centistokes), heavy silicone oil (densiron) is also available that sinks in water and hence can be used to tamponade inferior retina better<sup>8</sup>. Perfluorocarbon liquids are an important contribution made by Stanley Chang to VR surgery<sup>9</sup>. They have indeed revolutionized the way surgery is being done. These heavier than water liquids are used intra operatively to facilitate various procedures like, inverting the flap of giant retinal tear, performing relaxing retinectomies, displacement of sub retinal fluid, blood etc, floating dislocated intra ocular lens, stabilizing the posterior pole for peripheral dissection etc. Perfluoro carbon liquids are mostly used as intra operative agents and only rarely are used for long term

(medium term) tamponade as with perfluoro phenanthrene (vitreol). Silicone oil is still the best long term tamponading agent available although the search is on for a better substitute.

## UPDATE ON SURGICAL TECHNIQUES

**Suture less vitrectomy<sup>10,11</sup>:** This innovation for the vitreo-retinal surgeon is similar to what the phaco emulsification was for the anterior segment surgeon. The appeal of not having to suture the sclerotomies is attractive, but perhaps not the most important. The fact that smaller openings are made in the sclera is perhaps more important. The entry is made trans-conjunctivally and using a trocar and cannula system. A deliberate mismatch is aimed between the conjunctival and scleral opening by pulling the conjunctiva to one side while penetrating the eye wall. The entry into the eye itself is done in a two step fashion with an acute angled intra scleral track followed by a less acute entry across the last part of sclera and the ciliary body. Entry perpendicular to sclera is avoided at all costs. The cannula should ideally rest at an acute angle to the sclera and not at 90 degrees. Similar principles hold good for 23 and 25 gauge instrumentation. 25 gauge instruments are more slender and prone to get bent especially if significant dissection is needed. Most of the intra ocular forceps and scissors are available in the small dimensions so that for most purposes, the sclerotomies need not be enlarged. Once the surgery is completed, a deliberate pressure is applied on the site after the cannula is removed till all leak stops. In case of doubt, one does not hesitate to place a single stitch of 7-0 or 8-0 vicryl across the conjunctiva and the sclera, rather than risk post operative hypotony and infection. The suture less vitrectomy cannot be done in cases with previous conjunctival scarring; in cases requiring buckle placement (since conjunctiva needs to be opened); and for surgeries requiring enlargement of sclerotomy as in IOFB, complicated PVR etc. Recently 27 gauge vitrectomy has also been tried and shown to be possible in selected indications<sup>12</sup>.

## ENZYME ASSISTED VITRECTOMY

Lysing the adhesion of the vitreous to the retina using pharmacological means could potentially help in simplifying the vitrectomy. This concept has been tried with use of plasmin, urea etc. Microplasmin is a synthetic preparation and hence does not need to be prepared from patient's plasma. The results from Trese et al have shown useful application in management of retinal detachment secondary to Retinopathy of prematurity<sup>13</sup> as well in congenital retinoschisis<sup>14</sup>. Similar positive effect was noted with microplasmin-a recombinant molecule consisting of the catalytic domain of human plasmin<sup>15</sup>.

## CHROMOVITRECTOMY<sup>16</sup>

This term has been applied to the use of several dyes and drugs to stain various structures to facilitate their identification and removal.

**Sodium fluorescein:** Fluorescein has been used to stain the vitreous. This facilitates a more complete removal of the vitreous.

**Triamcinolone acetonide<sup>17</sup>:** This has been used both to identify the residual vitreous as well as for internal limiting membrane. Injected immediately after anterior vitrectomy, the crystals enable identification of the residual vitreous and enable proper induction of the posterior vitreous detachment. If injected after PVD has been induced and core vitrectomy performed, the crystals can outline the ILM and help its removal.

**Indocyanine green:** This dye stains the ILM preferentially and enables its removal with considerable ease. However there is significant risk of toxicity to retina and retinal pigment epithelium. Phototoxicity is also enhanced due to dye- light interaction<sup>18</sup>. Most surgeons have drifted away from ICG as a tool for ILM staining.

**Trypan blue<sup>17</sup>:** This dye which is often used by anterior segment surgeons to stain the anterior capsule of the lens can also be used to stain the ILM. However greater concentration is required. The staining is less intense

than with ICG but in most cases suffices. Toxicity to trypan blue is not a major issue.

**Infra cyanine green (0.5mgs/ml)** has been successfully used to stain ILM in macular hole surgery as well as in removing residual ILM after ERM removal. Unlike ICG, it does not contain Iodine. Several reports attest to its safety.

**Brilliant blue green (BBG)** has been used in a concentration of 0.25 mgs/ ml to stain ILM in macular hole surgery. The specific advantage of BBG is that it does not stain ERM but selectively stains ILM very well. Toxicity to RPE and retina have been reported with this dye as well<sup>19</sup>. Patent blue stains the ILM and ERM weakly.

Experimental studies on outer blood retinal barrier used measurements of trans epithelial electrical resistance (TER) and observation of monolayer of RPE cells under transmission electron microscope. Most studies have shown significant toxicity of ICG unlike other drugs<sup>20</sup>.

## MEMBRANE PEELING TECHNIQUES

Traditionally the three port vitrectomy enabled membrane peeling with one instrument while the other hand held the light pipe. True bimanual surgery requires use of two active instruments such as the forceps and scissors. Bimanual dissection in the retinal periphery is possible in aphakic and pseudophakic eyes, using the microscope illumination and facilitation by scleral indentation. A fourth port allows either a hand held light pipe (held by assistant) or one can fix a light pipe such as the torpedo light pipe. Illumination can be combined with infusion or one can also use illuminated forceps. The Topcon's offis microscope offers slit illumination that enables visualization of the retina without need for endoilluminator. Bimanual surgery has enabled rapid and precise dissection of diabetic membranes. However one must be conscious of the continuous traction being applied by the forceps which can result in inadvertent and uncontrolled forward pull on the retina that can result in iatrogenic retinal breaks. Use of high speed cutters with cutting port close to the tip of the instrument has enabled removal of most membranes with cutter and thus minimize the use of scissors and forceps in diabetic retinopathy.

Removal of the internal limiting membrane has been advised as a means of reducing the risk of postoperative macular pucker in eyes being operated for retinal detachment with PVR.

The use of wide field visualization system has provided with a panoramic view of the whole of the retina, thus enhancing a more complete removal of all traction.

## RELAXING RETINECTOMIES

Zivojnovic<sup>21</sup> popularized the concept of cutting the contracted retina in order to permit the rest of the retina to get reattached. With experience one can judge which part of the retina is contracted and plan the area to be excised. With the wide spread use of perfluorocarbon liquids, it has become possible to reattach the retina even with 360 degree retinectomy. In most cases of retinal detachments secondary to penetrating trauma, the retina could be variably incarcerated in the wound. This is best managed by a liberal retinectomy.

## SUBMACULAR SURGERY

Mathew Thomas popularized the concept of removing submacular choroidal neovascular membranes through a small retinotomy created posteriorly near the horizontal raphe<sup>22</sup>. Special instruments were devised to reach the membrane, dissect it from the RPE and the retina and deliver into the vitreous cavity. Contrary to popular concepts, the retinotomy did not need treatment with laser. With the advent of anti VEGF drugs and photodynamic therapy, the need for submacular surgery has diminished grossly. Submacular surgery is still useful for removing massive submacular hemorrhages<sup>23</sup>. Such haemorrhages are commonly seen after trauma, age related macular degeneration and idiopathic polypoidal

choroidal vasculopathy (IPCV). Use of tissue plasminogen activator along with vitrectomy has helped liquefy the blood and suck out the same through a relatively small retinotomy. Sub RPE hemorrhages however are not accessible for this approach.

### **SURGERY FOR RETINAL DETACHMENTS ASSOCIATED WITH RETINOPATHY OF PREMATURITY**

Although surgery for stage 5 ROP have been in vogue for some time with predictably very poor results, lens sparing vitrectomy for stage 4a and 4b ROP has become popular in the recent years<sup>24</sup>. The technique is possible in eyes that had good peripheral retinal ablation and yet developed retinal detachment. These eyes can develop retinal detachment at the site of the ridge or optic disc or both. Lens sparing vitrectomy can be performed through 2 or 3 port approach. In contrast to surgeries on stage 5 ROP, the results are more gratifying.

### **SURGERY FOR MACULAR HOLE**

Macular hole surgery has become more or less standardized with vitrectomy, ILM peeling and gas tamponade. The ILM in most cases is stained with one of the several dyes described above. With experience, the ILM peeling can be done quite atraumatically. In general the ILM is peeled up to the arcades.

### **SURGERY FOR COMPLICATIONS OF RETINOSCHISIS<sup>25</sup>**

Vitrectomy approach may be indicated in eyes with juvenile retinoschisis if 1. There is rhegmatogenous retinal detachment secondary to outer layer breaks or breaks in both layers. 2. Vitreous hemorrhage due to bleed from unsupported retinal blood vessels 3. Overhanging cyst over the macula. 4. Traction on macula due to the taut inner layer.

The understanding that the inner layer can act as a membrane and prevent the retinal reattachment has lead to excision of this layer in selected cases to facilitate better surgical success.

### **SURGERY FOR AGE RELATED MACULAR DEGENERATION**

Cases with macular damage despite anti VEGF drugs, and PDT have sometimes been managed by macular translocation. Although the concept is not new, different modifications have been described. The original technique described by Machemer involved 360 degree retinotomy and induction of retinal detachment and rotating the retina to the desired position and fixing the same<sup>26</sup>. There are considerable problems in inducing the retinal detachment as well as rotating the retina. Tano described a technique of limited retinotomy<sup>27</sup> and de Juan described a technique of shifting the macula by in folding the sclera<sup>28</sup>. This technique resulted in limited macular translocation and not often predictably. Eckardt popularized the technique of combining the macular translocation with surgery on the oblique muscles in order to correct the torque so induced<sup>29</sup>. Vitrectomy has also been used to perform epimacular brachy therapy using Strontium 90 for a 4 minute exposure as treatment of CNVM secondary to AMD<sup>30</sup>.

### **THE RETINAL PROSTHESIS**

The concept of bypassing the retinal processing of visual information using an artificial chip is very attractive. The present types of such artificial retinal prosthesis are either placed in front of the retina (epiretinal prosthesis)<sup>31</sup> or between the retina and the RPE (subretinal prosthesis)<sup>32</sup>. This type of implant requires the other layers of the retina to be functional although the photoreceptor layer may be atrophic. Since the information

is fed into the bipolar layer, the processing power of the retina is utilized to some extent.

Most of the retinal prosthesis are in experimental trials on limited subjects and need more improvisation in the resolution of the image obtained as well as the technique before they can be applied to a larger population on routine basis. Currently the indications for use are in end stage retinitis pigmentosa and age related macular degeneration.

### **INTRA VITREAL DRUGS**

The blood retinal and blood aqueous barriers preclude accumulation of high concentration in the vitreous cavity of most of the drugs administered systemically. Hence, the need to inject drugs directly into the vitreous cavity so as to achieve effective concentrations. The commonly administered drugs are as follows:

Antibacterial antibiotics: Vancomycin, Amikacin, and Ceftriaxime.

Anti fungal antibiotics: Amphotericin-B; Voriconazole, Fluconazole

Anti viral drugs: Gancyclovir

Steroids: Triamcinolone acetonide, Dexamethasone, Flucinolone acetonide

Anti VEGF drugs: Pegaptanib sodium, Bevacizumab, Ranibizumab

Anti Metabolites: Methotrexate

### **INTRA VITREAL DRUG DELIVERY DEVICES**

In view of the short half life of the drugs injected in the vitreous cavity, attempts have been made to develop slow release devices. The first device was the implant used for sustained release of gancyclovir<sup>33</sup>. This needed surgery to implant a relatively large device that is sutured to the sclera. Retisert is a similar device made to release fluocinolone in cases of uveitis<sup>34</sup>. The 'Ozurdex' is an injectable device containing a totally biodegradable material of dexamethasone combined with polyglycolic acid. It is injected through a 23 gauge needle and lasts up to 6 months.

Another device with fluocinolone has also gone through clinical trials. Although it is injected through a 25 gauge needle, it is not totally biodegradable. The tube remains in the vitreous cavity permanently.

A helical implant that is screwed into the eye has also been tried. This device has the largest surface area for the elution of the drug. However part of the device remains extra ocular (subconjunctival), and hence there is a risk of erosion and infection<sup>35</sup>.

The future may show more of these drug delivery devices that may incorporate drugs such as anti VEGF agents etc. Drugs combined with fibrin sealant have also been tried as sustained release devices. These are placed close to the sclera<sup>36</sup>.

### **THE EYE UNDERGOING VITREORETINAL SURGERY**

Visualisation is of utmost importance during vitreo retinal surgery. A lot of newer anterior segment innovations interfere significantly with proper visualization during vitreo retinal surgery and hence provide a challenge for the surgeon.

**Multifocal IOLs:** the concentric rings and the varying refraction from centre to periphery of the IOL can sometimes pose problems<sup>37</sup>.

**Radial keratotomy scars:** especially when they extend too far into the centre. Fortunately with the advent of LASIK, eyes presenting with retinal detachment and radial keratotomy scars have become rare.

**Eyes that underwent LASIK:** although these eyes do not produce any interference with visualization, one must be conscious of the presence of LASIK flap. Corneal epithelium removal should be avoided.

**Eyes with phakic IOLs:** Phakic IOLs are performed in high myopia that is not amenable for LASIK and these eyes are also at risk for retinal detachment. In addition to problems of multiple optical interfaces caused

by the IOL in front of the crystalline lens, measures such as paracentesis could be potentially dangerous.

**Eyes with Scleral fixated IOLs-** During fluid air exchange, the air collects freely in front of the IOL and this can interfere with visualization.

**Eyes that have two IOLs in the eye-** Some aggressive surgeons implant one IOL in the anterior chamber even if one IOL has dislocated into the vitreous cavity. Considering the problems that these eyes would have suffered, retinal detachment is not uncommonly associated with this situation. Managing these eyes may involve removal of both the IOLs as the first step.

**Eyes with epiretinal prosthesis-** Eyes undergoing retinal prosthesis as treatment for retinitis pigmentosa can also develop retinal detachments, considering that the prosthesis is fixed to retina using retinal tacks etc.

**Eyes with retinal inserts-** The management of retinal detachments in these eyes is no different from routine cases except that the retisert may need to be removed at the same time.

**Eyes that underwent permanent keratoprosthesis-** the risk of retinal detachment is very high in eyes that undergo permanent keratoprosthesis<sup>38</sup>. The situation is complicated by small aperture of the optical cylinder (usually 3 mm), presence of retrocylinder membranes and altered anatomy of the limbus. Very often the keratoprosthesis lamina may have to be temporarily removed to facilitate the retinal reattachment surgery following which it is replaced.

## REFERENCES

1. **Machemer R, Norton E Vitrectomy, a pars plana approach II. clinical experience.** *Mod Probl Ophthalmol.* 1972;10:178-85.
2. **Maghales O Jr, Chong L, De Boer C, Bhadri P, et al.** Vitreous dynamics: Vitreous flow analysis in 20, 23 and 25 gauge cutters. *Retina* 2008;28:236-241
3. **Fang SY, De Boer CM, Humayun MS.** Performance analysis of new generation vitreous cutters. *Graefes Arch Clin Exp Ophthalmol.* 2008; 246:61-7
4. **Ben-nun J.** Cornea sparing by endoscopically guided vitreoretinal surgery. *Ophthalmology* 2001; 108: 1465-1470
5. **Norton EW.** Intra ocular gas in the management of selected retinal detachments. *Trans Am Acad Ophthalmol and Otolaryngol.* 1973; 77:85-98
6. **Cibis PA.** Treatment of retinal detachment by injection of silicon oil into the vitreous body. *Ber Zusammenkunft Dtsch Ophthalmol Ges* 1965; 66:433-4
7. **Zivojnovic R.** Silicone oil in the vitreoretinal surgery. *Dodrecht. Martinus Nijhoff/Dr W Junk publishers,* 1987
8. **Stappler T, Heinmann H, Gibran SK, Groenewald C, Pearce IA, Wong D.** Densiron-68 heavy silicone oil in cases of PVR. *Anatomical and functional outcomes.* *Ophthalmologie* 2009;106:320-6
9. **Coll GE, Chang S, Sun J, Wieland MR, Berrocal MH.** Perfluorocarbon liquid I the management of retinal detachment with proliferative vitreoretinopathy. *Ophthalmology* 1995; 102:630-8
10. **De Juan, Fujii GY, Humayun MS, Pieramici D.** 25 gauge minimally invasive vitrectomy system (MIVS): early clinical experience. *Vitreous society annual meeting, Puerto Rico,* 2001
11. **Hu Y, Chen W, Hou P.** Comparison of 25 and 23- gauge sutureless microincision vitrectomy surgery in the treatment of various vitreoretinal diseases. *Eye*, 2009- e publication.
12. **Oshima Y, Wakabayashi T, Sato t, Ohji M, Tano Y.** A 27- gauge instrument system for transconjunctival sutureless microincision vitrectomy surgery. *Ophthalmology* 2009 OCT. 30; E publication ahead of print
13. **Wu WC, Dresner KA, Lai M, Capone A, Trese MT.** Plasmin enzyme assisted vitrectomy for primary and reoperated eyes with stage 5 retinopathy of prematurity. *Retina* 2008;28:S75-80
14. **Wu WC, Dresner KA, Capone A, Williams GA Trese MT.** Plasmin enzyme assisted vitreoretinal surgery in congenital X- linked retinoschisis: surgical techniques based on a new classification system. *Retina* 2007;27:1079-85
15. **de Smet MD, Gandorfer A, Stalmans P, Veckeneer M, Feron E, Pakola S, Kampik A.** Microplasma intra vitreal administration in patients with vitreomacular traction scheduled for vitrectomy: the MIVI trial. *Ophthalmology* 2009;116:1349-1355
16. **Farah ME, Marurico M, Rodrigues EB.** Dyes in ocular surgery: Principles for use in chromovitrectomy. *Am J Ophthalmol.* 2009;148:332-40
17. **Rodrigues EB, Maria M, Meyer CH, Pehna FM, Dib E, Farah ME.** Vital dyes in chromovitrectomy. *Curr opin Ophthalmol.* 2007;18:179-187
18. **Haritoglou C, Gandorfer A, Gass CA, Schaumberger M, Ulbig MW, Kampik A.** indo cyanine green assisted peeling of the internal limiting membrane in macular hole surgery affects visual outcome: clinicopathological correlation. *Am J Ophthalmol* 2002;134:836-841
19. **Malerbi F, Maia M, Farah ME.** Sub retinal brilliant blue migration during epiretinal membrane peeling. *Brit J Ophthalmol* 2009; 93:1687
20. **Mennel S, Thumann G, Peter S, Meyer CH, Kroll P.** Influence of bital dyes on the function of the outer blood-retinal barrier in vitro. *Klin Monbl Augenheilkd.* 2006;223:568-76
21. **Claes C, Zivojnovic R.** Treatment of posterior eye segment complications after perforating trauma. *Bull Soc Belge Ophthalmol.* 1992; 245:61-3
22. **Saxena S, Thomas MA, Melberg NS.** Sub macular surgery. *Ind J Ophthalmol.* 1997;45:77-92
23. **Tenant MT, BZorrillo JL, Regulo CD.** Management of submacular hemorrhage. *Ophthalmol clin north am.* 2002; 15:445-452
24. **Bhende P, Gopal L, Sharma T, Verma A, Biswas RK.** Functional and anatomical outcomes after primary lens-sparing pars plana vitrectomy for stage 4 retinopathy of prematurity. *Ind J Ophthalmol.* 2009; 57:267-271
25. **Rosenfeld PJ, Flynn HW Jr, Mc Donald HR, Rubsam PE, Smiddy WE, Sipperley JO, Boniuk I, Packer AJ.** Outcomes of vitreoretinal surgery in patients with X-linked retinoschisis. *Ophthalmic Surg Lasers.* 1998 Mar;29(3):190-7.
26. **Machemer R.** Macular translocation. *Am J Ophthalmol.* 1998;125:698-700
27. **Ohji M, Fujikado T, Kusaka S, Hayashi A, Hosohata J, Ikano Y, Sawa M, Kubota A, Hashida N, Tano Y.** Comparison of three techniques of foveal translocation in patients with subfoveal choroidal neovascularisation resulting from age related macular degeneration. *Am J Ophthalmol* 2001;132:888-896
28. **Fujii GY, Au Eong KG, Humayun MS, de Juan E Jr.** Limited macular translocation: current concepts. *Ophthalmol Clin North Am.* 2002;15:425-36
29. **Eckardt C, Eckardt U, Conrad HG.** Macular rotation with and without counter rotation of the globe in patients with age related macular degeneration. *Graefes Arch Clin Exp Ophthalmol.* 1999; 237:313-325
30. **Avila MP, Farah ME, Santos A, Duprat JP, Wood ward BW, Nau J.** Twelve month short term safety and visual acuity results from a multicenter prospective study of epiretinal strontium-90 brachytherapy with bevacizumab for the treatment of sub foveal choroidal neovascularisation secondary to age related macular degeneration. *Br J ophthalmol.* 2009;93:305-9
31. **Humayun MS, Dorn JD, Ahuja AK, Caspi A, Filley E, Dagnelie G, Salzmann J, Santos A, Duncan J, Dacruz L, Mohand-Said S, Elliott D, McMahon MJ, Greenberg RJ.** Preliminary 6 month results from the argus ii epiretinal prosthesis feasibility study. *Conf Proc IEEE Eng Med Biol Soc.* 2009;1:4566-8
32. **Kelly SK, Shire DB, Chen J, Doyle P, Gingerich MD, Drohan WA, Theogarajan LS, Cogan SF, Wyatt JL, Rizzo JF.** Realisation of a 15- channel hermetically encased wireless sub retinal prosthesis for the blind. *Conf Proc IEEE Eng Med Biol Soc.* 2009;1:200-3
33. **Chang M, Dunn JP.** Ganciclovir implant in the treatment of cytomegalovirus retinitis. *Expert Rev Med Devices.* 2005;2:421-7
34. **Brunn MV, Nguyen QD.** Fluocinolone acetonide intravitreal sustained release device- a new addition to the armamentarium of uveitic management. *Int J Nanomedicine* 2007;2:55-64
35. **Mello-filho PA, Guven D, Beeley NR, de Juan E Jr, Erickson SR.** Helical intravitreal triamcinolone acetonide implant : a 6 month surgical feasibility study in rabbits. *Ophthalmic surg Lasers Imaging.* 2009;40:160-8
36. **Martin NE, Kim JW, Abramson DH.** Fibrin sealant for retinoblastoma: where are we? *J Ocul Pharmacol Ther* 2008;24:433-8
37. **Mainster MA, Reichel E, Warren KA, Harrington PG.** Ophthalmoscopy and vitreoretinal surgery in patients with an ARRAY refractive multifocal intra ocular lens implant. *Ophthalmic surg lasers.* 2002;33:74-6
38. **Hughes EH, Mokete B, Ainsworth G, Casswell AG, Eckstein MB, Zambarakji HJ, Gregor Z, Rosen PH, Herold J, Lera S, Liu CS.** Vitreo retinal complications of osteo odontokeratoprosthesis surgery. *Retina* 2008;28:1138-45

## NOBEL PRIZE IN MEDICINE

**Dr. Robert Edwards**, 85 year old Professor Emeritus at the University of Cambridge has been awarded the Nobel Prize in Medicine for the year 2010, for his work on *In vitro* Fertilisation (IVF), which led to the birth of the world's first test tube baby. His work has made fundamental contributions like how human egg mature?, how different hormones regulate their maturation? and at which point of time the eggs are susceptible to the fertilising sperm? Dr. Edwards research has so far led to the birth of around 4 million people.

**Nobel Prize in Chemistry 2010:** Richard Heck of US and Ei-Ichi Megishi and Akira Suzuki of Japan shared the Nobel Prize in Chemistry for developing a process called palladium – catalysed cross coupling – a means of knitting carbon atoms together paving the way for new drugs to fight cancer, HIV, herpes virus infections, as well as developing revolutionary plastics for consumer application such as ultra thin computer monitors.

**Nobel Prize in Physics 2010:** Two Russians Scientists Dr. Andre Geim and Dr. Constantan Novoselov were awarded in Nobel Prize in physics 2010 for their ground-breaking work on graphene- a form of carbon touted as the wonder material of the 21<sup>st</sup> century.